

## Global Multiphase Water Analysis

Franklin R. Robertson/ES42  
205-922-5836

The atmospheric hydrologic cycle is fundamental to the character of Earth's climate. While the distribution and variability of rainfall obviously affect human activities, even the distribution of clouds and water vapor are intimately connected to climate and its associated human impacts. Unfortunately, accurate water budgets are currently lacking because of the considerable uncertainties associated with cloud climatologies, water-vapor measurements, and vertical motion fields. Current four-dimensional data analysis models have yet to incorporate sufficiently accurate representations of moist physics required to adequately couple radiation, dynamics, and cloud production. Researchers have been developing an integrated analysis of vapor, cloudiness, and precipitation (2.5-degree spatial resolution,  $\pm 70.00$  degrees latitude, daily and longer time scales) over various time periods that coincide with major field-study campaigns (Tropical Ocean Global Atmosphere-Coupled Ocean Atmosphere Response Experiment) and algorithm test-bed development (1987-88 NASA/National Oceanic and Atmospheric Administration Pathfinder Period).

A unique aspect of this study is a semiprognostic approach whereby parameterized bulk microphysics and convective processes are used along with the observational constraints to drive conservation equations for water vapor, cloud liquid and ice, and

precipitation. Only moisture fields are prognosed, with the temperature, horizontal wind, and vertical motion being taken from the European Center for Medium-range Weather Forecasting's gridded analyses. Employed are wind and temperature fields from global gridded analyses and water vapor from the Special Sensor Microwave/Imager to constrain vapor and condensate budgets. Researchers analyze the resulting three-dimensional fields of moisture variables and examine the ice budgets for consistency with observations of cloudiness. This methodology has led to an analysis of atmospheric water substance that is consistent with satellite observations—the best estimates of water transport by wind—and simple but physically based representations of cloud microphysical processes.

During the past year, researchers have been able to evaluate the quality of the synthesized fields by comparing them to several independent satellite data sets: (1) synthetic 6.7-micron channel imagery constructed from analyzed thermodynamic fields versus HIRS CH12 and Geostationary Operational Environmental Satellite 6.7 channel data, (2) cold cloud top-frequency statistics of synthesized clouds versus those detected by HIRS, and (3) the horizontal structure of diagnosed precipitating ice against that derived from the Special Sensor Microwave/Imager and MSU. The role of kinematic transport on large-scale cloud distributions associated with baroclinic events in middle latitudes versus convective outflows has been examined.

This project's analysis technique is expected to contribute significantly to

understanding the processes that maintain the observed atmospheric distribution of clouds, water vapor, and precipitation. It is also serving as a test-bed for physics process subroutines models that will be incorporated into improved global climate models.

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